MULTIMEDIA UNIVERSITY

STUDENT ID NO

MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2018 / 2019

PPH0125 - MECHANICS

(Foundation in Engineering)

4 MARCH 2019
2.30 p.m. – 4.30 p.m.
(2 Hours)

INSTRUCTIONS TO STUDENT

1. This question paper consists of **FOUR** printed pages, excluding the cover page and appendices, with **FIVE** questions.
2. Answer all questions. The distribution of the marks for each question is given.
3. Write all your answers in the answer booklet provided.
4. All necessary workings must be shown.

QUESTION 1 (10 marks)

a) Given $\mathbf{P} = 5\mathbf{i} + 3\mathbf{j} - \mathbf{k}$ and $\mathbf{Q} = 3\mathbf{i} - \mathbf{j} - 2\mathbf{k}$. Determine the cross product of $\mathbf{P} \times \mathbf{Q}$.

(2 marks)

b) A vehicle starts from rest with a uniform acceleration and in 10.0 s has moved a distance of 150.0 m.

i. What is the acceleration of the vehicle?

(1 mark)

ii. What is its speed at $t = 10.0$ s?

(1 mark)

c) A person stands on a scale in an elevator at rest on the 35th floor of a building. The scale reads 784 N. As the elevator moves up, the scale reading increases to 850 N. What is the acceleration of the elevator?

(2 marks)

d) Two objects (A and B) hang stationary from strings going around pulleys of different diameters as shown in **Figure Q1.1**. If mass of object B is 0.6 kg, determine the mass of object A.

(2 marks)

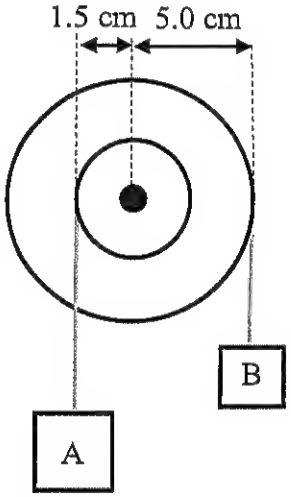

Figure Q1.1

Continued...

e) The box in **Figure Q1.2** is being pushed up the ramp with a force of 50.0 N. If the 50.0 N force is parallel with the ramp, what is the work done by the force?

(2 marks)

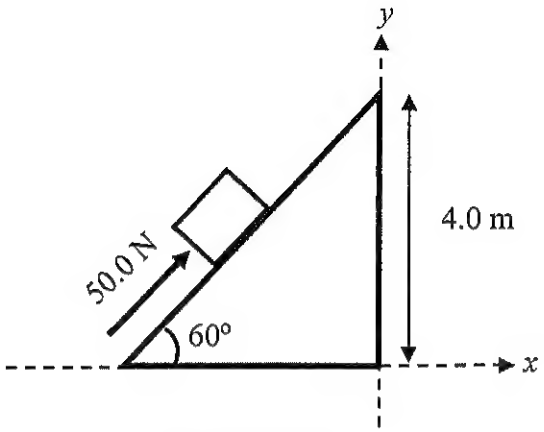

Figure Q1.2

QUESTION 2 (10 marks)

a) In a diving competition, a diver performs 2.5 somersaults in 1.6 s. What is the average angular speed of the diver in rad/s?

(2 marks)

b) A flywheel has a constant angular deceleration of 2.2 rad/s.

i. Find the angle through which the flywheel turns as it comes to rest from angular speed of 210.0 rad/s.

(2 marks)

ii. What is the time required for the flywheel to come to rest?

(2 marks)

c) A light thread with a block of mass m = 0.6 kg tied to its end is wound on a wheel of radius R = 0.4 m as shown in **Figure Q2.1**. The moment of inertia of the wheel, $I = 1.1 \times 10^{-1}$ kg.m^2, and the axis of the wheel is frictionless. If the block is released from rest, find its speed just before it hits the floor.

(4 marks)

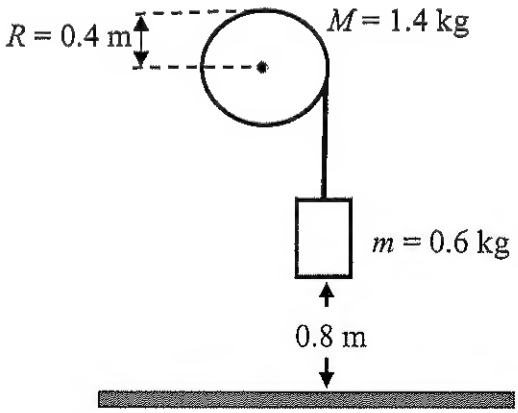

Figure Q2.1

Continued...

QUESTION 3 (10 marks)

a) Three masses are placed on x-axis shown in **Figure Q3.1**. If the net gravitational force acting on m_2 due to the other two masses is zero, find the distance between m_2 and m_3.

(3 marks)

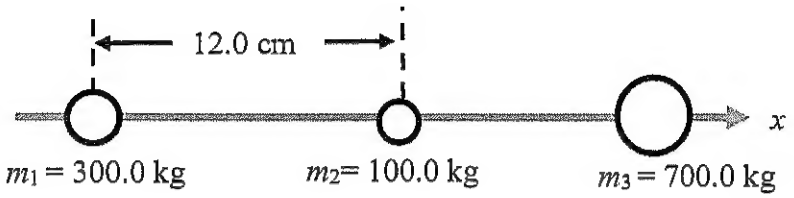

Figure Q3.1

b) A satellite of mass 500.0 kg orbiting the Earth at an altitude of 2.0×10^5 m.

i. Calculate the potential energy of the satellite-Earth system.

(2 marks)

ii. If the satellite orbiting the Earth in a circle, calculate the tangential speed of the satellite.

(2 marks)

iii. What is period of the satellite orbiting the Earth?

(3 marks)

QUESTION 4 (10 marks)

a) A 90.0-kg metal cylinder with a length of 0.5 m and each end of area 7.5×10^{-3} m^2 is placed vertically on one end on a floor. What pressure does the cylinder exert on the floor?

(2 marks)

b) A 200.0-kg load is hung on a wire with an original length of 0.3 m, cross sectional area of 7.9×10^{-5} m^2, and Young's modulus of 7.7×10^8 N/m^2. Calculate the extension of the wire.

(3 marks)

c) A plastic sphere floats in water with 50.0% of its volume submerged. The same sphere floats in oil of density 1430.0 kg/m^3 with part of its volume submerged.

i. Determine the density of the plastic sphere.

(3 marks)

ii. Find the percentage of the volume of the sphere that submerged in the oil.

(2 marks)

Continued...

QUESTION 5 (10 marks)

a) A block of mass 3.0 kg is suspended from a fixed point by means of a spring of original length 1.2 m and spring constant $k = 42.0$ N/m.

i. Find the length of the spring when the block rests in equilibrium.

(3 marks)

The block is then pulled down until the spring stretches to length of 2.2 m, and is released so that the block oscillates in simple harmonic motion.

ii. Calculate the period of the oscillation.

(2 marks)

iii. What is the amplitude of the oscillation?

(1 mark)

b) **Figure Q5.1** shows a graph of displacement versus time for a simple harmonic motion. Based on the graph, find:

i. Frequency.

(2 marks)

ii. If the equation that representing the motion is written as $y = A\cos(\omega t + \phi)$, find ϕ.

(2 marks)

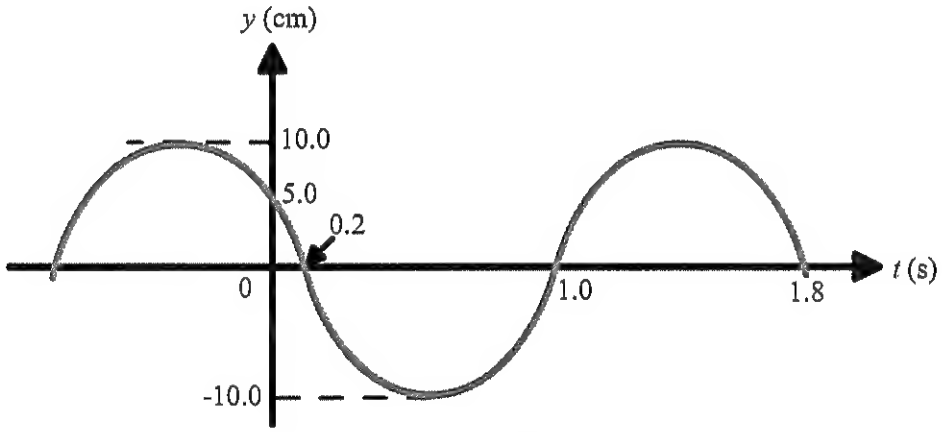

Figure Q5.1

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APPENDIX I

Physical Constants

Quantity	Symbol	Value
Electron mass	m_e	9.11×10^{-31} kg
Proton mass,	m_p	1.67×10^{-27} kg
Elementary charge	e	1.602×10^{-19} C
Gravitational constant	G	6.67×10^{-11} N.m^2 /kg^2
Gas constant	R	8.314 J/K.mol
Hydrogen ground state	E_o	-13.6 eV
Boltzmann's constant	k_B	1.38×10^{-23} J/K
Compton wavelength	λ_c	2.426×10^{-12} m
Planck's constant	h	6.626×10^{-34} J.s
Speed of light in vacuum	c	3.0×10^8 m/s
Rydberg constant	R_H	1.097×10^7 m^{-1}
Acceleration due to gravity,	g	9.8 m /s^2
Atomic mass unit (1u)	u	1.66×10^{-27} kg
Avogadro's number	N_A	6.023×10^{23} mol^{-1}
Threshold of intensity of hearing	I_o	1.0×10^{-12} W /m^2
Coulomb constant	k	9.0×10^9 N m^2 /C^2
Permittivity of free space	ϵ_o/κ_o	8.85×10^{-12} C^2/N.m^2
Permeability of free space	μ_o	$4\pi \times 10^{-7}$ H/m

Energy equivalent of atomic mass unit:

One atomic mass unit (1.0 u) is equivalent to 931.5 MeV

Earth:

Gravity	=	9.8 m/s^2
Radius	=	6.4×10^6 m
Mass	=	6.0×10^{24} kg

Moon:

Mass	=	7.4×10^{22} kg
Radius	=	1.7×10^6 m

Sun:

Mass	=	2.0×10^{30} kg
Radius	=	6.96×10^8 m

Mean distance from:

Sun to Earth	=	1.50×10^{11} m
Moon to Earth	=	3.85×10^8 m

APPENDIX II

List of formulas

$$y = kx^n \qquad \frac{dy}{dx} = knx^{n-1}$$

$$\sin\theta = \frac{\text{opposite}}{\text{hypotenuse}} \qquad \cos\theta = \frac{\text{adjacent}}{\text{hypotenuse}} \qquad \tan\theta = \frac{\text{opposite}}{\text{adjacent}}$$

$$\sin\alpha + \sin\beta = 2\cos\left(\frac{\alpha-\beta}{2}\right)\sin\left(\frac{\alpha+\beta}{2}\right)$$

$$\sin(\alpha-\beta) + \sin(\alpha+\beta) = 2\sin\alpha\cos\beta$$

$$v = v_o + gt \qquad y - y_o = v_o t + \frac{1}{2}gt^2 \qquad v^2 = v_o^2 + 2g(y - y_o)$$

$$y - y_o = \left(\frac{v_o + v}{2}\right)t$$

$$a_c = \frac{v^2}{r} \qquad F_g = G\frac{m_1 m_2}{r^2} \qquad U_g = -G\frac{m_1 m_2}{r} \qquad T^2 = K_s r^3$$

$$\tau = r \times F \qquad \sum\tau = \tau_{net} = I\alpha \qquad I = \sum mr^2$$

$$v = r\omega$$

$$L = r \times p = I\omega \qquad K = \frac{1}{2}I\omega^2 \qquad |\tau| = |r||F|\sin\theta$$

$$T_s = 2\pi\sqrt{\frac{m}{k}} \qquad T_p = 2\pi\sqrt{\frac{l}{g}} \qquad T = \frac{2\pi}{\omega} = \frac{1}{f} \qquad \bar{y} = \frac{\sum_{i=1}^{N} m_i y_i}{\sum_{i=1}^{N} m_i}$$

$x = A\cos\omega t$ $\qquad$ $x = A\sin\omega t$

$v = -\omega A\sin\omega t$ $\qquad$ $v = \omega A\cos\omega t$ $\qquad W_F = |r||F|\cos\theta$

$a = -\omega^2 A\cos\omega t$ $\qquad$ $a = -\omega^2 A\sin\omega t$

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t}$$

$$v = v_o + at \qquad x - x_o = v_o t + \frac{1}{2}at^2 \qquad v^2 = v_o^2 + 2a(x - x_o) \qquad x - x_o = \left(\frac{v_o + v}{2}\right)t$$

$$W = mg \qquad \sum F = F_{net} = ma \qquad f_s \le \mu_S F_N \qquad f_k = \mu_K F_N$$

$$p = mv \qquad \sum F = \frac{\Delta p}{\Delta t} \qquad \Sigma W = \frac{1}{2}mv^2 - \frac{1}{2}mu^2$$

$$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2 \qquad m_1u_1 + m_2u_2 = (m_1 + m_2)v \qquad P = \frac{W}{t} = \frac{E}{t} = \frac{Fd}{t} = F\bar{v}$$

$$K = \frac{1}{2}mv^2 \qquad PE_s = \frac{1}{2}kx^2 \qquad F_s = -kx \qquad PE_G = mgy$$

$$\bar{x} = \frac{\sum_{i=1}^{N} m_i x_i}{\sum_{i=1}^{N} m_i} \qquad W_{Fs} = \frac{1}{2}kx_i^2 - \frac{1}{2}kx_f^2$$